(12) UK Patent Application (19) GB (11) 2 335 798 (13) A

(43) Date of A Publication 29.09.1999

(21) Application No 9806507.1

(22) Date of Filing 26.03.1998

(51) INT CL[6]
H01Q 5/01 9/04

(52) UK CL (Edition Q)
H1Q QJA QKA

(56) Documents Cited
GB 2233156 A US 5394159 A
AP-S International Symposium 1986 Digest. Antennas and Propogation (Cat No 86CH2325-9) pp 361-364

(58) Field of Search
UK CL (Edition P) H1Q QDN QJC QKA QKN QKX
INT CL[6] H01Q
Online:- WPI, INSPEC, JAPIO, CLAIMS

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(54) Abstract Title
Enhanced bandwidth antenna

(57) Patch antennas which are lightweight and occupy a small volume and are therefore especially suitable for mobile phones. The antenna operating bandwidth is switched between transmitter and receiver frequency bands by means of a PIN diode. The PIN diode connects electrically larger and smaller patches which are adjacent to each other on the same substrate but electrically isolated.

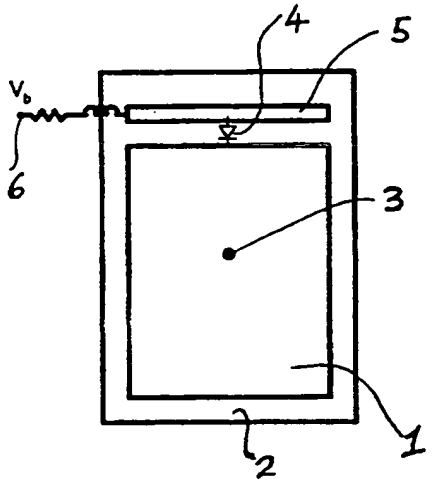

Figure 1

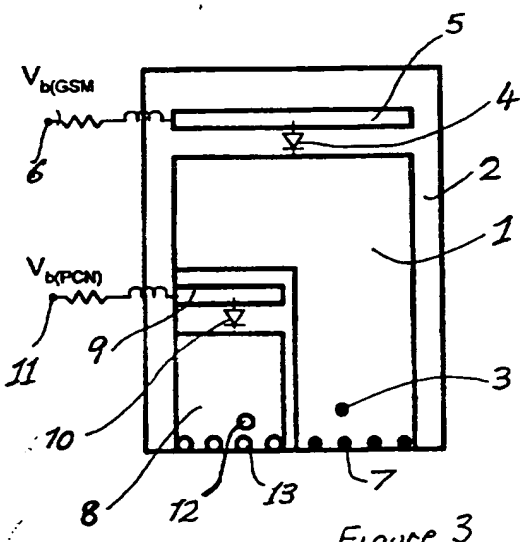

Figure 3

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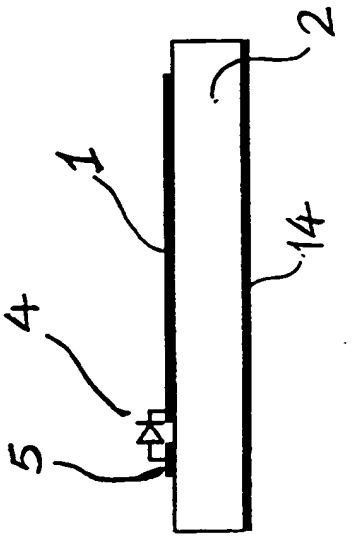

Figure 2

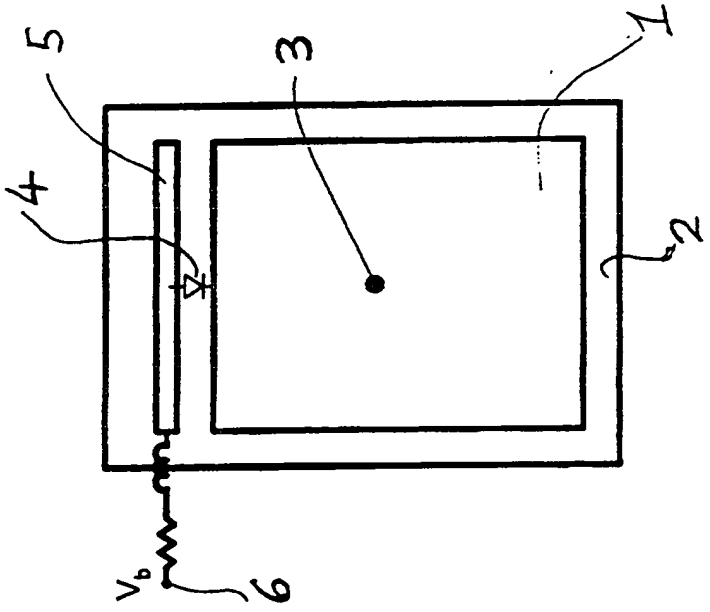

Figure 1

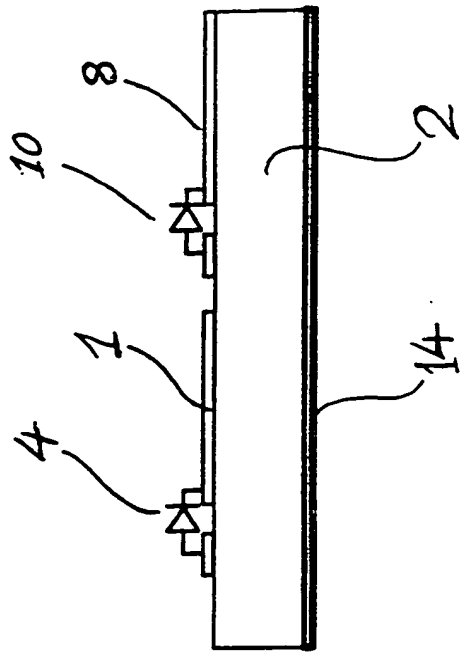

Figure 4

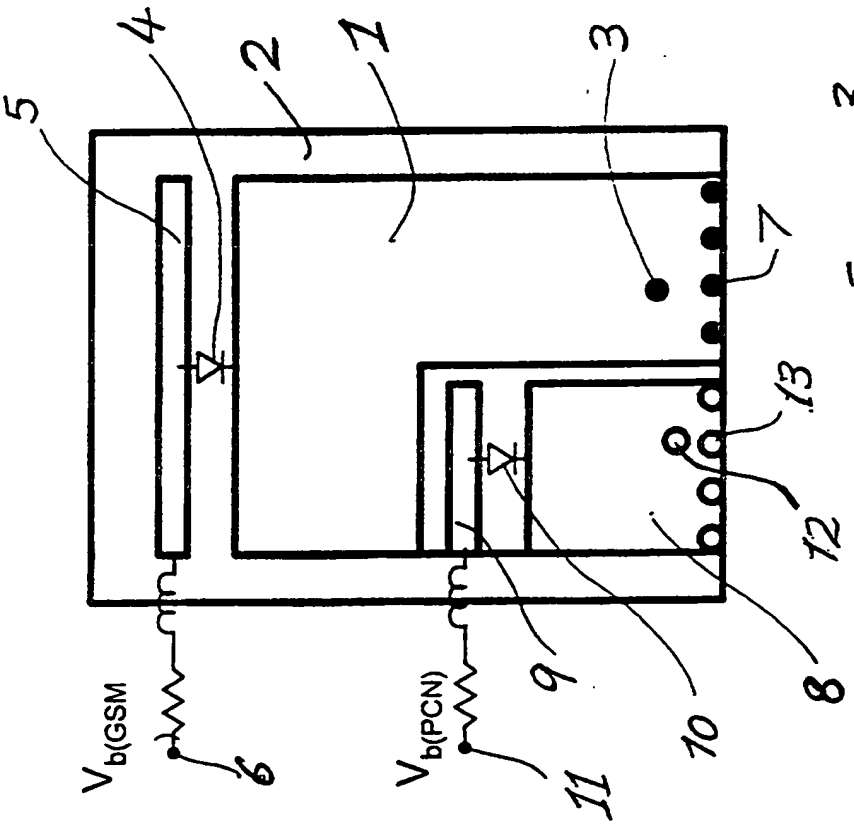

Figure 3

Enhanced bandwidth antennas

This invention relates to antennas and in particular it relates to enhanced bandwidth antennas primarily, though not exclusively, for use with mobile phones.

Low profile enhanced bandwidth PIFA antennas are known from the paper by K L Virga and Y Rahmat-Samii , IEEE Transactions on microwave theory and techniques Vol. 45 No. 10 October 1997. In their paper Virga and Y Rahmat-Samii discuss the way in which varactor diodes may be used to connect together electrically, two sections of a PIFA element that are separated physically. Such antennas are, however unsuitable for use with mobile communication systems such as GSM and PCN due to the high level of generation of harmonics caused by the varactor diodes.

Directive antennas contained within mobile phone hand sets need to be light in weight and of as small a volume as possible. Microstrip antennas suit these conditions of light weight and small volume but , for thin substrates have relatively narrow bandwidth.

It is an object of this invention to provide a lightweight patch antenna of small volume, suitable for use with mobile phone hand sets.

According to the invention there is provided a microstrip antenna comprising a larger patch and a smaller patch, both patches formed on the

same substrate and the larger and smaller patches connected by a PIN diode and means for applying a voltage to the PIN diode to connect electrically the larger and smaller patches.

According to a further aspect of the invention there is provided a dual band microstrip antenna having a higher frequency antenna and a lower frequency antenna, both antennas formed on the same substrate and each comprising a larger patch and a smaller patch connected by a PIN diode and means for applying a voltage to the PIN diodes to connect electrically the larger and smaller patches.

Two embodiments of the invention will now be explained with reference to the accompanying figures in which:

figure 1 is a plan view of a switchable patch antenna,

figure 2 is a side view of the antenna of figure 1,

figure 3 is a plan view of a dual band switchable antenna,

figure 4 is a side view of the antenna of figure 3.

A first embodiment of the invention is illustrated in figures 1 and 2. The antenna of figures 1 and 2 is for incorporation in a mobile phone which is designed to operate with a single communications system e.g. GSM.

With reference to figures 1 and 2, a primary patch 1 is formed on substrate 2 with a feed at 3 and a ground plane at 14. The secondary patch 5 may be switched to connect electrically with primary patch 1 by the application of a voltage (e.g. 3 volts) at 6. A voltage applied at 6 will cause the PIN diode to change from open circuit to short circuit.

Electrical connection of secondary patch 5 to primary patch 1 changes the effective length and consequently the resonant frequency of the patch antenna 1 to provide an antenna suitable for use in a different frequency band. It has been found that PIN diodes as used in this embodiment do not cause unacceptable generation of harmonics.

Therefore instead of the more usual broad antenna bandwidth required to cover the complete range of frequencies for receiver , transmitter and guardband, effectively two antennas of relatively narrow bandwidth are deployed. By means of the switching of PIN diode 4 the antenna operates either in the transmitter band or in the receiver band. Each of the two operating conditions require therefore only a narrow bandwidth.

The thickness (depth) of substrate 2 has an effect on antenna bandwidth such that the thicker the substrate the greater the bandwidth. If required a matching network can be used between the feed 3 and primary patch 1 to increase the bandwidth.

A further embodiment of the invention is illustrated in figures 3 and 4. The antenna of figures 3 and 4 is a switchable quarter wave microstrip antenna for incorporation in a so called dual band mobile phone. Dual band phones are designed to be capable of operation with two different communications systems e.g. GSM and PCN.

With reference to figures 3 and 4, two separate switchable antennas are formed on substrate **2**. The first antenna, the GSM antenna, comprises a primary patch **1** and secondary patch **5** with a feed at **3**. A PIN diode **4** is switched from open circuit to short circuit by the application of a voltage at **6**. In this embodiment the shorting pins **7** along one edge of patch **1** are included to reduce the length of the antenna.

The second antenna shown in figures 3 and 4, the PCN antenna, comprises a primary patch **8**, a secondary patch **9** and has a feed at **12**. The PIN diode **10** is switched from open circuit to short circuit by the application of a voltage at **11**. One edge of primary patch **8** is short circuited by shorting pins **13**.

Claims

1. A a microstrip antenna comprising a larger patch and a smaller patch, both patches formed on the same substrate and the larger and smaller patches connected by a PIN diode and means for applying a voltage to the PIN diode to connect electrically the larger and smaller patches.

2. A dual band microstrip antenna having a higher frequency antenna and a lower frequency antenna, both antennas formed on the same substrate and each comprising a larger patch and a smaller patch connected by a PIN diode and means for applying a voltage to the PIN diodes to connect electrically the larger and smaller patches.

3. A microstrip antenna as in claims 1 or 2 where the antennas are quarter wave resonant patch antennas.

4. A microstrip antenna as in any previous claim where a matching circuit is included between the antenna and the antenna feed.

5. A microstrip antenna as in any previous claim where one edge of the antenna is short circuited.

The Patent Office

Application No: GB 9806507.1 **Examiner:** Dr E P Plummer
Claims searched: all **Date of search:** 10 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H1Q (QDN, QKA, QKN, QKX, QJC)

Int Cl (Ed.6): H01Q

Other: Online:- WPI, INSPEC, JAPIO, CLAIMS

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB2233156A	SEC STATE DEFENCE	
A	US5394159	AT&T	
X	AP-S International Symposium 1986 Digest. Antennas and Propogation (Cat. No. 86CH2325-9) volume 1 pages 361-4: AS Daryoush et al: Optically tuned patch antenna for phased array applications		1-4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.